Brownlee Condition Monitoring

Idaho POWER
An IDACORP Company

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Idaho Power

Fully Integrated Electric Utility

Thermal Facilities And Capacities

Coal

▲ Jim Bridger		770.5 MW*
▲ North Valmy		283.5 MW*
▲ Boardman		64.2 MW*
	Total	1,118.2 MW

Natural Gas

▲ Bennett Mountain		172.8 MW
▲ Danskin		270.9 MW
▲ Langley Gulch		318.5 MW
	Total	762.2 MW

Diesel

▲ Salmon Diesel		5.0 MW
	Total	1,885.4 MW

Hydroelectric Facilities and Nameplate Capacities

1	Hells Canyon	391.5 MW
2	Oxbow	190.0 MW
3	Brownlee	585.4 MW
4	Cascade	12.4 MW
5	Swan Falls	27.2 MW
6	C. J. Strike	82.8 MW
7	Bliss	75.0 MW
8	Lower Malad	13.5 MW
9	Upper Malad	8.3 MW
10	Lower Salmon	60.0 MW
11	Upper Salmon	34.5 MW
12	Thousand Springs	8.8 MW
13	Clear Lake	2.5 MW
14	Shoshone Falls	12.5 MW
15	Twin Falls	52.9 MW
16	Milner	59.4 MW
17	American Falls	92.3 MW
	Total	1,709.0 MW

* Idaho Power Co. Share

Brownlee Powerhouse
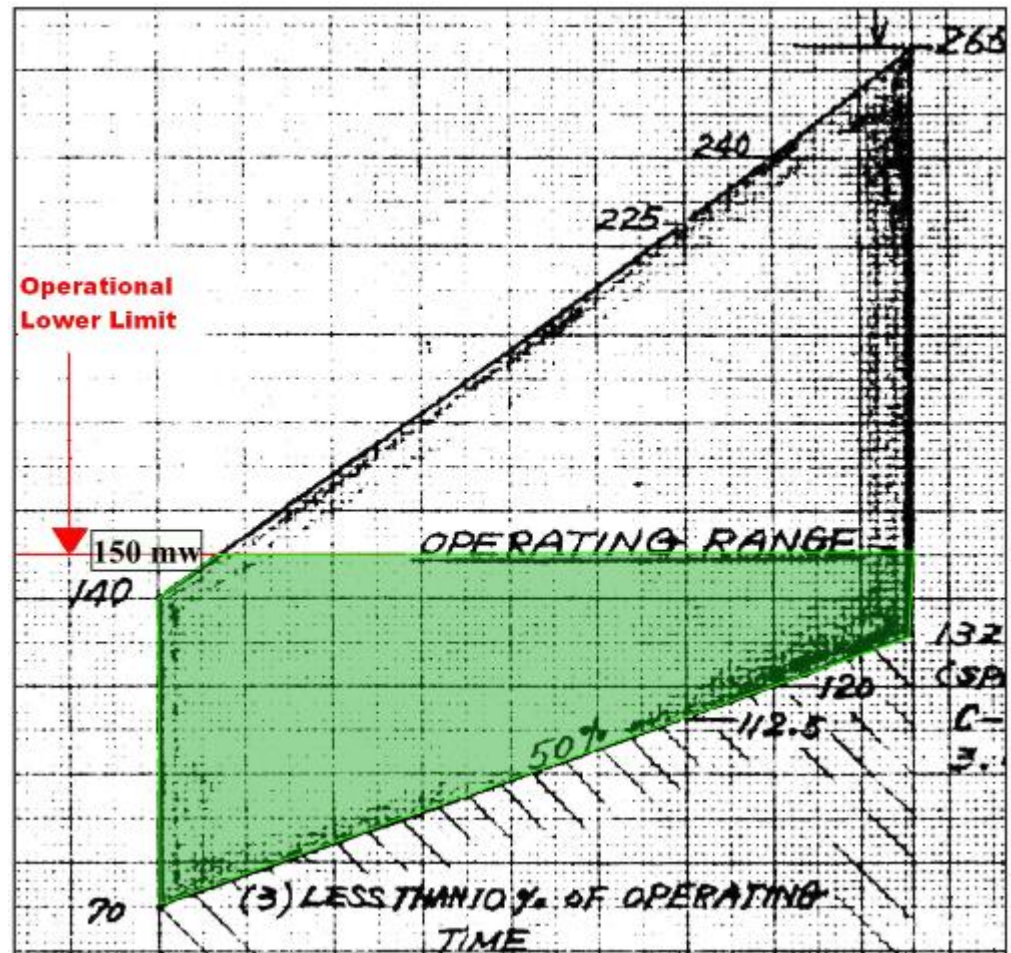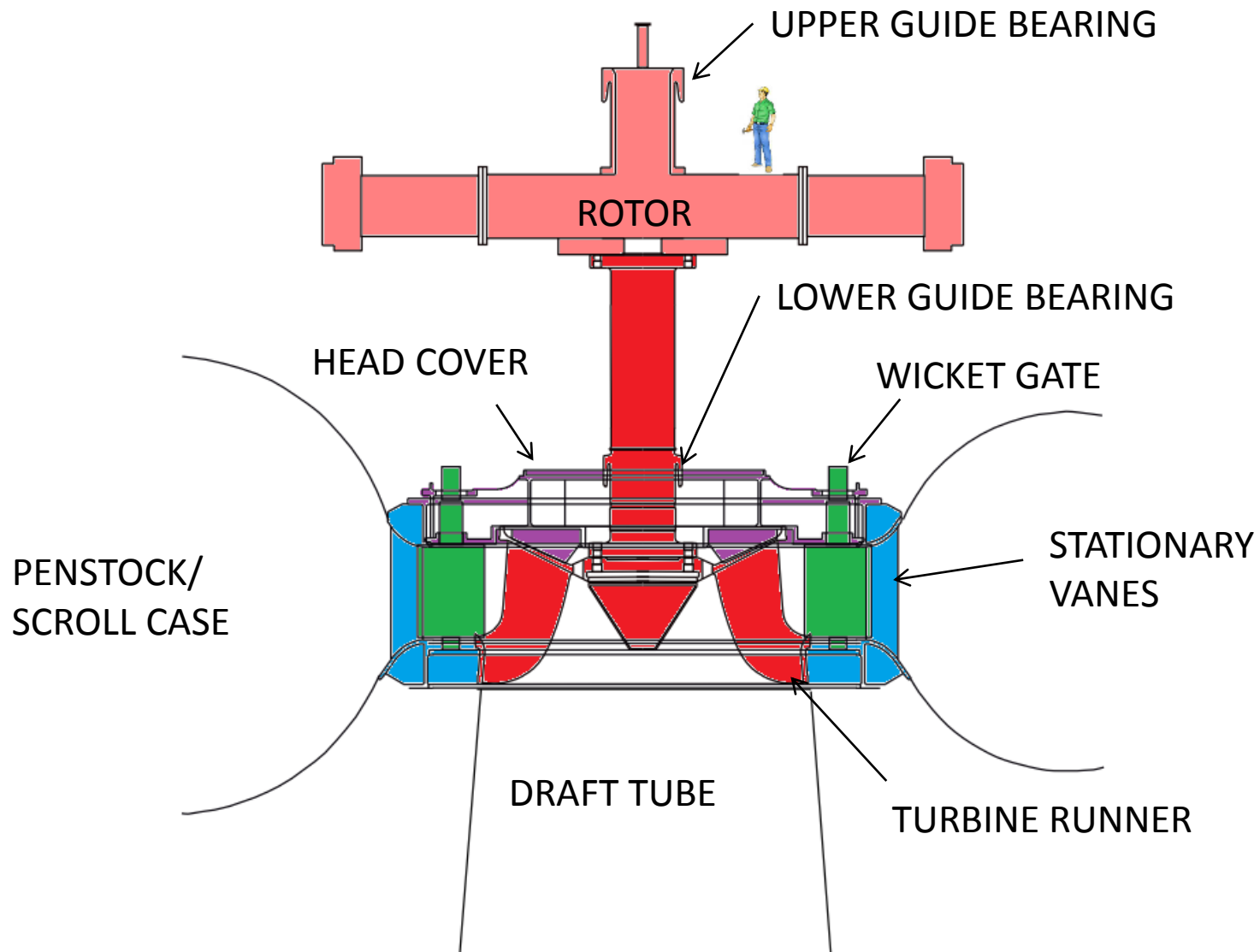
- Units 1-4
- Unit 5

Project Background

- Goal: Extend #5 Operating Range for Wind Integration
- Protect unit when running at part load
- Data acquisition to support project integration testing
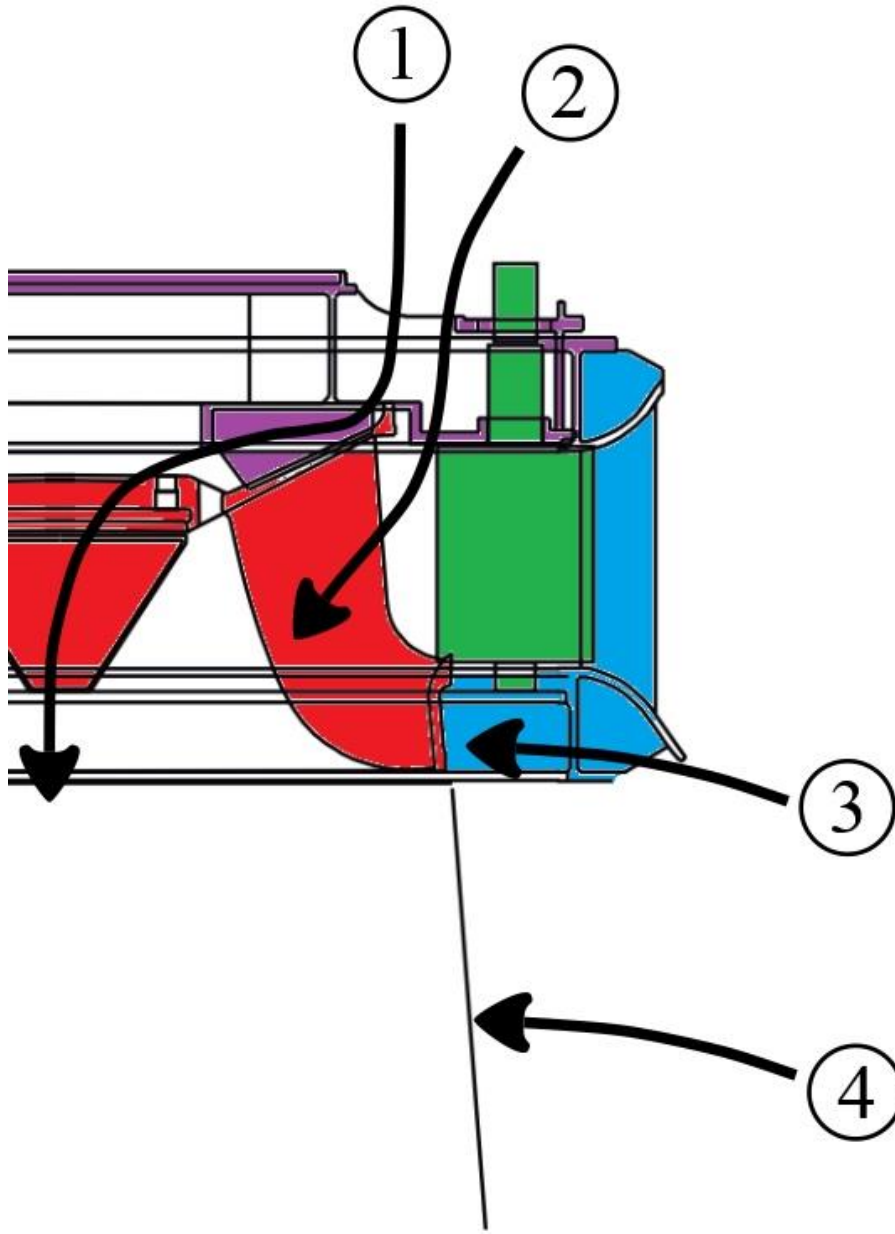- LT trending & setup for preventive maintenance

- Test Objectives
  - Utilize entire operational envelope defined by the manufacturer , using enhanced control of air venting into the turbine

Brownlee Unit #5

UPPER GUIDE BEARING

ROTOR

LOWER GUIDE BEARING

HEAD COVER

WICKET GATE

PENSTOCK/
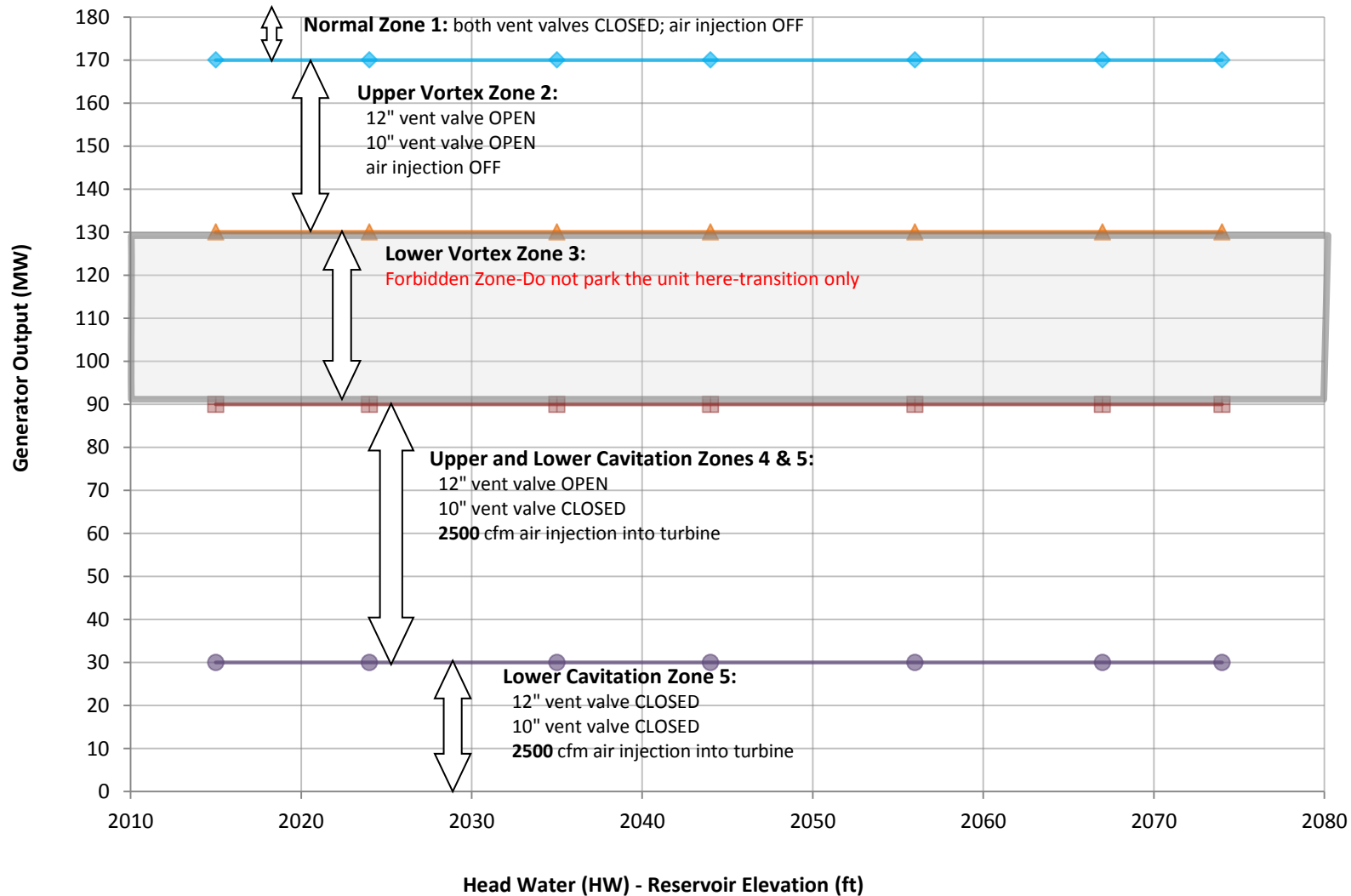SCROLL CASE

STATIONARY
VANES

DRAFT TUBE

TURBINE RUNNER

Air Venting and Injection Paths

1. Runner Cone
2. HP region between wickets & runner buckets
3. Behind runner band
4. Discharge ring below runner

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Smoothing Air System

Normal Zone 1: both vent valves CLOSED; air injection OFF

Upper Vortex Zone 2:
12" vent valve OPEN
10" vent valve OPEN
air injection OFF

Lower Vortex Zone 3:
Forbidden Zone-Do not park the unit here-transition only

Upper and Lower Cavitation Zones 4 & 5:
12" vent valve OPEN
10" vent valve CLOSED
2500 cfm air injection into turbine

Lower Cavitation Zone 5:
12" vent valve CLOSED
10" vent valve CLOSED
2500 cfm air injection into turbine

Generator Output (MW)

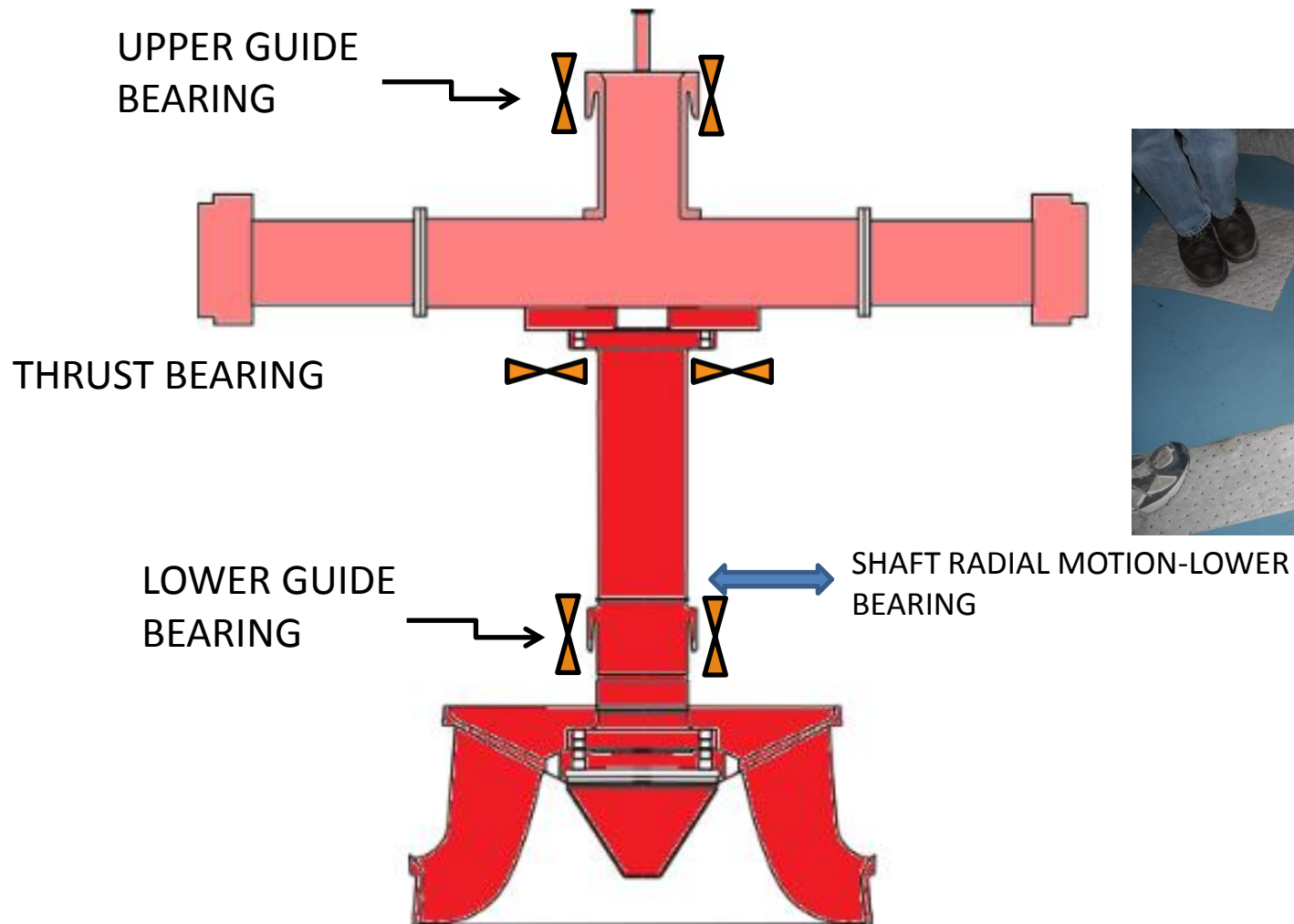Head Water (HW) - Reservoir Elevation (ft)

Vibration Monitoring Overview

- 3500 Hydro Monitors
- 2 radial planes of vibration
- Thrust vibration
- Draft tube seismic vibration
- Penstock and draft tube dynamic pressure

2008 Sensor Locations-Rotating Elements

UPPER GUIDE BEARING

THRUST BEARING

LOWER GUIDE BEARING

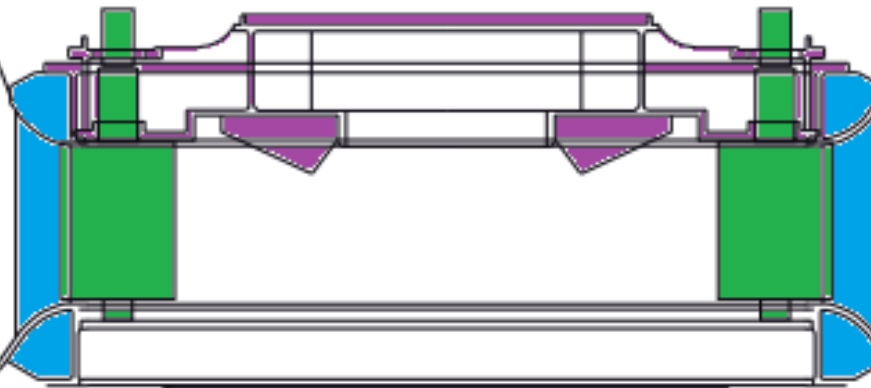SHAFT RADIAL MOTION-LOWER BEARING

2008 Sensor Locations-Stationary & Pressures

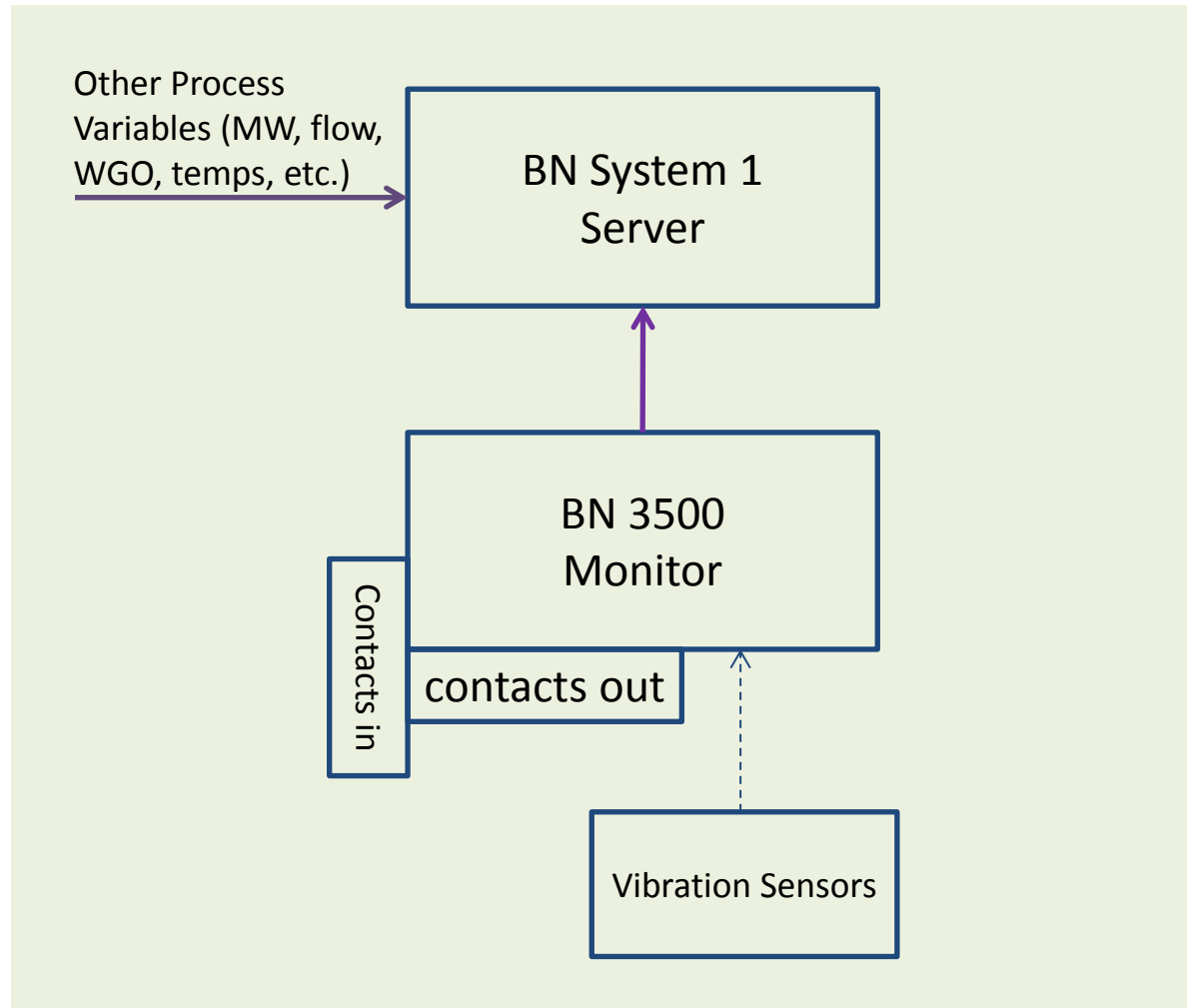PRESSURE-PENSTOCK

1   2   3   4

ACCEL-DRAFT TUBE

PRESSURE-DRAFT TUBE

System 1

- Industrial Server running a Windows Server OS

- System 1 Data Acquisition Software

- Network for remote access

- Smart Alerts & Notifications

Challenges of Accessing Data

Data acquisition today is very challenging as for two reasons:

1) High volume of data needed to be transported and the system needed to transport the data.

2) Security Concerns
   - From Information Security group
   - From the Information Technology group
   - From the Compliance group

Challenges of Accessing Data

The desire is to be able to view and analyze the "as near real time" vibration data in the Corporate Headquarters to provide "near real time" advise to generation dispatchers for operational changes as to how the generator is being dispatched or to provide guidance to plant technicians as to adjustments to the auxiliary air handling control systems to minimize vibrations.

In addition to the near real time data, there was a desire to bring monthly archived data back into the Corporate headquarters for trending analysis.

Challenges of Accessing Data

Due to its black-start capabilities and its designation the Brownlee power plant has in place a frame relay communications system. This communications system was established to eliminate routable protocols outside of the plant and remove dial-up connectivity to ensure compliance with CIP-002-3 R3.

We made an attempt to use the remote desktop to access the vibration monitoring system through our secure frame relay system, however, the speed of the updated screen images made it impossible to use the vibration unit effectively.

Challenges of Accessing Data

This left us with a problem as to how to bring large amounts of data back to the Corporate Headquarters from the plant without violation of IPCo standards and in accordance with the existing CIP version 3 standards.

At the present time, due to the CIP version 3 impacts on plant communications and operations, the decision was made was made to delay the development of a communications system to bring the data into the corporate headquarters.

Challenges of Accessing Data

The decision was unpopular with engineering, however, it made sense to delay the development of the communications system until the CIP version 5 standards became effective. The CIP version 5 standards appeared to allowed more flexibility and less impact on plant operations.

Upon the release of the CIP version 5 standards it became clear that all of our hydroelectric facilities would be classified as "Low Impact" facilities. This opened the door to develop a secure but less intrusive communications solution to establish connectivity to plant equipment.

Challenges of Accessing Data

Medium Impact BES Cyber Assets Requirements,

   CIP-005-5 R1

   Cyber Assets connected to a network via a routable protocol shall reside within a defined ESP.

   All External Routable Connectivity must be through an identified Electronic Access Point (EAP).

   Require inbound and outbound access permissions, including the reason for granting access, and deny all other access by default.

   Have one or more methods for detecting known or suspected malicious communications for both inbound and outbound communications.

Challenges of Accessing Data

Medium Impact BES Cyber Assets Requirements, CIP-005-5 R2

Utilize an Intermediate System such that the Cyber Asset initiating Interactive Remote Access does not directly access an applicable Cyber Asset.

For all Interactive Remote Access sessions, utilize encryption that terminates at an Intermediate System.

Require multi-factor authentication for all Interactive Remote Access sessions.

Challenges of Accessing Data

Power Production Engineering started to search for equipment solution which could provide security with a minimum impact to the budget.

Engineering contacted Schweitzer Engineering Labs (SEL) to evaluate their SEL-3620 Ethernet Security Gateway.

The requirements given to SEL was that the equipment must meet the "Medium Impact" CIP version 5 ESP requirements.

This requirement was requested due to the uncertainty associated with CIP v5 black-start plant designations.

Challenges of Accessing Data

SEL visited IPCo to discuss the requirements and present several solutions to our problem.

The package that SEL recommended was the SEL-3620. The SEL sales and engineering team were willing to provide a loaner and provide programming assistance to demonstrate the devices features.

SEL visited IPCo 3 times over the course of 2 months to help with programming and demonstration of the SEL-3620. The device performed well and communicated with the vibration monitoring server, other manufacture's relays using their proprietary software, and of course communicated well with SEL relays.

Challenges of Accessing Data

The SEL-3620 provides:

1. Centralized Access to Relays and Intelligent Electronic

   Devices (IEDs)

2. Embedded White list Antimalware

3. Substation Firewall and IPsec VPN Endpoint

4. Strong Auditability and User Activity Reports

5. IED Password Management

6. NERC CIP Requirement Support

7. Serial-to-Ethernet Transceiver

8. Virtual Software Client Support

Challenges of Accessing Data

It certainly appeared that Engineering had found a solution to plant communications issues as the SEL-3620 could be used to securely connected to an Ethernet network.

*   The SEL-3620 provides all the necessary security to keep those who are unauthorized out of the plant equipment communications network.

*   The SEL-3620 provides Ethernet connectivity to the vibration monitor server allowing remote access.

*   The SEL-3620 provides serial port emulation which allows serial port connectivity to legacy equipment using original manufactures software.